schools and colleges, and we trust that when another decade's work of the London or any other School Board has to be summarised, the so-called extra subjects will have become an integral part of the elementary education of the country. Such institutions as that opened at Birmingham will greatly help on the cause of scientific education. The standard of teaching we are glad to see is high, the best science schools of the Continent being taken as models; and we trust the Mason College will never degenerate into a mere technical training-school. Under the liberal principles for its conduct laid down by the founder, it is capable of the widest development in every direction; whether it may form the nucleus of a Birmingham University remains to be seen. Its working will be watched with the greatest interest by all who have at heart the raising of the standard of education in the country.

CHEMISTRY OF THE CARBON COMPOUNDS

Elements of Chemistry. By William Allen Miller, M.D., &c. Revised and in great part re-written by Henry E. Armstrong, Ph.D., F.R.S., and Charles E. Groves, F.C.S. Part III.—Chemistry of Carbon Compounds, or Organic Chemistry. Section I.—Hydrocarbons, Alcohols, Ethers, Aldehydes, and Paraffinoid Acids. Fifth edition. (London: Longmans, Green and Co., 1880.)

THE study of the laws governing the combinations of molecules containing carbon is of the very first importance to chemical science, inasmuch as this study so well illustrates and extends the general laws of molecular combinations, that is to say, the general laws of the science of chemistry.

An almost innumerable array of facts concerning carbon compounds is to be found in the ordinary text-books; papers in the chemical journals sometimes contain generalisations drawn from certain classes of those facts: the later supplements to Watts's "Dictionary" contain the more important of the comparatively recent generalisations; but there has undoubtedly existed for some time among students of chemistry a wish for a text-book in which the leading facts concerning the compounds of carbon should be clearly stated, the general properties of, and general relation between groups of these bodies should be indicated, and summaries of the evidence in favour of or against the generally adopted structural formulæ of the more important compounds should be presented to the student, in order that he might thus have in one text-book such a fair compendium of the present state of this branch of the science as should furnish him with suggestions for work, by showing him what is clearly known, where exact knowledge ceases, and where even analogy lends but little help.

The first part of such a text-book English chemistry now possesses; let us hope that the second part of this admirable book will soon follow, and be worthy of that now published.

In their preface the editors—had we not better say at once the authors?—write: "Notwithstanding the extraordinary increase in the number of the carbon compounds, their study is gradually becoming simplified as the possibility is extended of arranging them in series and of

giving a general description of their chief properties applicable to all the members of the group."

There can be no hesitation in saying that the authors' work—more than any other text-book in the English language—will aid the advance of this, the only true method, of studying Organic Chemistry.

There are text-books of Organic Chemistry which tell the student that the structure of this or that compound "is represented by the following formula"; this book follows another and a better plan: the authors give a succinct and clear sketch of the evidence for and against all important structural formulæ, thus indicating the true value of these formulæ as condensed statements of chemical facts, and at the same time setting before the student examples of the application of the chemical method of inquiry.

The general principles underlying the formation of so-called structural formulæ are adverted to in more than one place by the authors.

These formulæ are based on the laws of "atom-linking," which again are deductions from the theory of quantivalence or valency, itself an outcome of the application of chemical methods of inquiry to the molecular theory of matter.

Although the volume before us is Part III. of a large work, the first part of which deals with chemical physics, it would nevertheless, we think, have been advisable to have given a brief sketch of the molecular theory of matter, and to have shortly stated—but more fully than is done on p. 42—the evidence on which is based the (chemically) all-essential difference between atom and molecule.

A little space might have been spared for an exposition of the laws of atom-linking, such as, but very much more condensed than, that in Lothar Meyer's "Modernen Theorieen."

In speaking of quantivalence, on p. 42, the authors do not explicitly state that it is the *atoms* of the elements which "are equivalent in combining or replacing power to one, two, three, four, five, or six monad atoms of hydrogen." Of course this is implied throughout the discussion which follows, but students sometimes fail clearly to grasp the difference between the old chemistry, which attempted, but failed, to determine equivalent weights of elements, and the new, which is so largely based on the equivalency of groups of atoms of the elements.

Frankland's "bond" explanation of valency is sketched, but so long as we have no definite physical conception of what a "bond" is, this explanation really explains nothing; such an expression as "two of the bonds neutralise each other" has no meaning, further than that the valency varies from a given number to two less than this number.

The authors give some examples of compounds, which seem to show that the valency of certain elementary atoms may vary from an odd to an even number; but they do not give examples which prove such a variation, e.g., MoCl_5 and MoCl_6 ; WCl_5 and WCl_6 ; NO , NO_2 and NH_3 .

The authors, probably wisely, do not very definitely express their opinion as to the exact meaning of a structural formula; they sometimes appear to regard these formulæ as real representations of the relative

mode of arrangement of atoms in a molecule, sometimes only as condensed statements of facts of formation and decomposition. If the former view be adopted it becomes a question whether the "structure" represented by the formula is that of the molecule when unacted upon by the molecules of foreign bodies, or only when a certain disposition of its parts has been induced by the action of the molecules of another substance.

Facts are certainly known which are best explained by supposing that a change of some kind precedes that process of complete molecular decomposition usually called a chemical reaction; indeed almost the only feasible hypothesis of chemical action supposes that chemical change—that is, change among the parts of the molecule—may be proceeding without a permanent molecular decomposition taking place. In the section on "Aldehydrols" the authors apparently admit some such hypothesis as this; they do not regard the non-isolation of a compound as proof of the non-existence of that compound; they explain processes of chemical change by supposing the existence of unstable molecular configurations intermediate between more stable and isolable configurations.

Recent work in chemical physics appears to lend some countenance to the idea that structural formulæ may roughly represent the configuration of molecules just previous to their passage into phases of "absolute instability" rather than their configuration when in phases which are themselves "absolutely stable."

Quite recently a distinct advance has been made in molecular theories by the recognition of what might be called *atomic induction*, that is, the influence exerted by one part of a molecule in modifying the chemical function of another part, or other parts, of the same molecule. Illustrations of this "orientation" are to be found in the production of the substituted derivatives of benzene and of the phenols; the generalisations made in these cases are clearly stated by the authors.

A very valuable section on the Van't Hof Le-Bel hypothesis of isomerism is to be found from pp. 983 to 993. (There is evidently an omission of part of a sentence at the top of p. 993.) The authors suggest a slightly modified form of this hypothesis. The fundamental assumption is made in these hypotheses that chemical energy is entirely potential, and that it is wholly due to the arrangement of the parts of the molecules. It seems possible however that chemical energy may be partly potential and partly kinetic, and that if any means could be found for measuring the change of entropy as well as the change of total intrinsic energy of chemical systems in their passage from one standard state to another, some light might be thrown on the question of isomerism.

In their general classification of carbon compounds the authors have adopted a scheme founded on the chemical function of these compounds; they group together hydrocarbons, alcohols, aldehydes, &c. They do not fail to indicate how function is associated with "structure." But in each of these great groups of compounds a classification founded more upon genetic relations is adopted; they consider a group of hydrocarbons, then the haloid derivatives of these hydrocarbons, and so on.

Most admirable tables are appended to all the more important groups; the usefulness of these tables may be

illustrated by reference to that on pp. 458-459, wherein the ethylic alcohols are arranged in *really* homologous series.

The acids are classified into various sub-groups, and the dependence of the function of the "acid hydrogen" on the "structure" of the other part of the molecule is indicated.

In speaking of the higher aromatic or "benzenoid" hydrocarbons, the happy expression is used of a closed chain containing "*loops*," and it is pointed out that "the formation of each new loop in the chain of carbon atoms tends to reduce the combining power by two units."

The proof (p. 399) that the carbon atoms in the olefines are not arranged in a closed chain is noteworthy, and may be taken as typical of the authors' method of dealing with such questions; basing a generalisation on carefully collected facts, and then applying their generalisation boldly, but without dogmatism.

The nomenclature of the work before us is much more self-consistent than that adopted in any other treatise on organic chemistry. Certain new names are introduced: thus, the bodies supposed to exist in aqueous solutions of many aldehydes—substances characterised by the groups $\text{CH}(\text{OH})_2$ —are called *aldehydrols*. A systematic nomenclature for the carbohydrates is proposed: those of the composition $\text{C}_6\text{H}_{12}\text{O}_6$ have names ending in *ose*, glucose being the best known example of this class; those of the composition $\text{C}_{12}\text{H}_{22}\text{O}_{11}$, which like cane-sugar produce two molecules of glucose on inversion, have names ending in *on*, e.g., saccharon; and those which on hydration give rise to the formation of a saccharon have names ending in *yn*, e.g., amylin. As another instance of the authors' attempt to systematise nomenclature may be noted their rules for the use of the Greek letters α , β , &c., in distinguishing isomeric derivatives (pp. 861-2, *note*).

Finally, I would draw attention to the authors' manner of dealing with physical methods of solving chemical problems: the physical method is so described that one cannot forget that it is to be used by a chemist—there is not first a little physics, and then a little chemistry; the problem is clearly chemical, the method only is physical.

A suggestion made in the preface seems most admirable, it is that "Each chemical school" would do well to "make the preparation by its students of certain substances in a state of purity a part of the ordinary course of study, and to give notice that these particular compounds are at the disposal of experts for the determination of physical constants."

Is there any probability of a treatise being written on Inorganic Chemistry conceived in the same spirit and carried out, as far as possible, on general lines similar to those of this most excellent work by Armstrong and Groves?

M. M. PATTISON MUIR

OUR BOOK SHELF

An Elementary Treatise on Solid Geometry. By W. Steadman Aldis, M.A. (Cambridge: Deighton, Bell, and Co., 1880.)

THE term "elementary" diagnoses this handy book to solid geometry from the more thorough works on the same subject by Messrs. Salmon and Frost. It is, to our mind, exceedingly well adapted to the requirements of that large class of students who, whilst requiring an acquaintance with this branch of study, are unable, either